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Olsen

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(54) **COMPACT MODULAR IN-THE-EAR HEARING AID**

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(73) Assignee: **Topholm & Westermann APS**, Vaerløse (DK)

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(51) **Int. Cl.**[7] **H04R 25/00**
(52) **U.S. Cl.** **381/322**; 381/323; 381/328
(58) **Field of Search** 381/60, 314, 322, 381/323, 324, 328; 181/130, 135; 73/585; 600/559

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,598,177	A	*	7/1986	McGroarty et al.	381/323
4,680,799	A		7/1987	Henneberger	
4,716,985	A	*	1/1988	Haertl	381/323
4,739,512	A	*	4/1988	Hartl et al.	381/324
4,870,688	A	*	9/1989	Voroba et al.	381/60
5,201,008	A		4/1993	Arndt et al.	
5,347,584	A	*	9/1994	Narisawa	381/328
5,790,672	A	*	8/1998	Klostermeier	381/322
5,889,874	A	*	3/1999	Schmitt et al.	381/322
5,995,636	A	*	11/1999	Topholm	381/322

FOREIGN PATENT DOCUMENTS

CH	68311	A5	5/1994
DE	41 21 311	C1	8/1992
DE	44 44 586	C1	2/1996
EP	0 311 233	A2	4/1989

* cited by examiner

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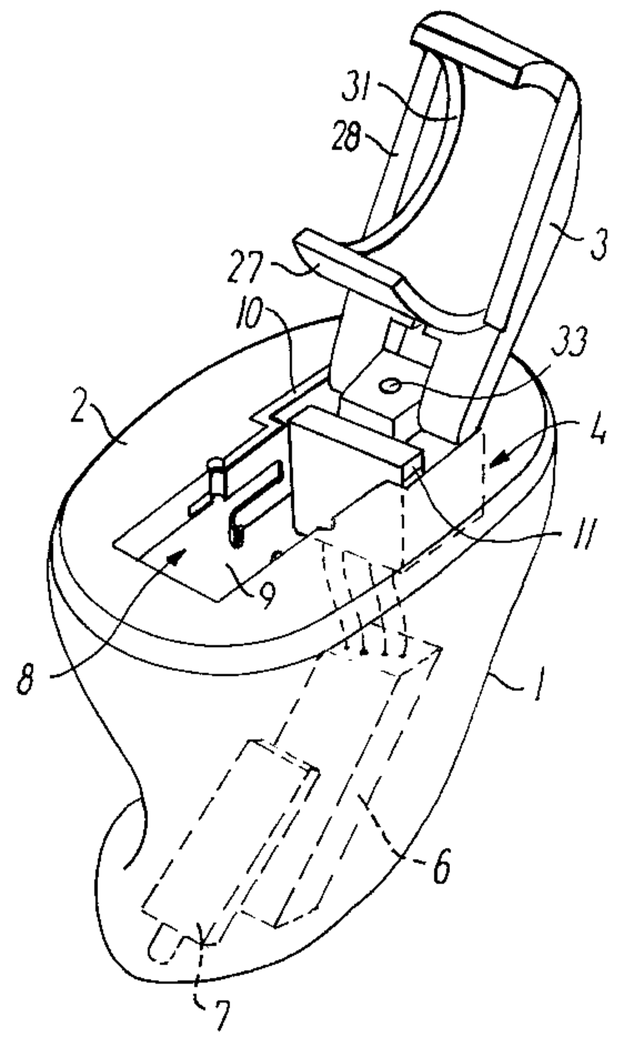
(57) **ABSTRACT**

A modular hearing aid for arrangement in a user's ear comprises a hollow plug (**1**) adapted to the ear canal and having a generally irregular conical shape and an exterior opening which is covered by a faceplate (**2**), in which a recess (**8**) is formed for removable arrangement of a battery (**23**) as well as an electronic module (**4**) comprising a microphone part (**5**), a signal processing part (**6**) and a sound reproducer (**7**). The recess (**8**) comprises a first region (**9**) for insertion of the battery (**23**) and a second region (**10**) coherent with the first region for placing of a socket part (**11**) of the electronic module (**4**), and at the edge of the recess (**8**) the faceplate (**2**) is formed with engaging means (**12–16**) for the socket part (**11**), whereas further parts of the electronic module (**4**) are placed below the faceplate (**2**). The recess (**8**) is formed such that at removal of the battery (**23**) the first and second regions (**9**, **10**) together allow passage also of said further parts (**6**,**7**) for removal of the complete electronic module.

11 Claims, 4 Drawing Sheets



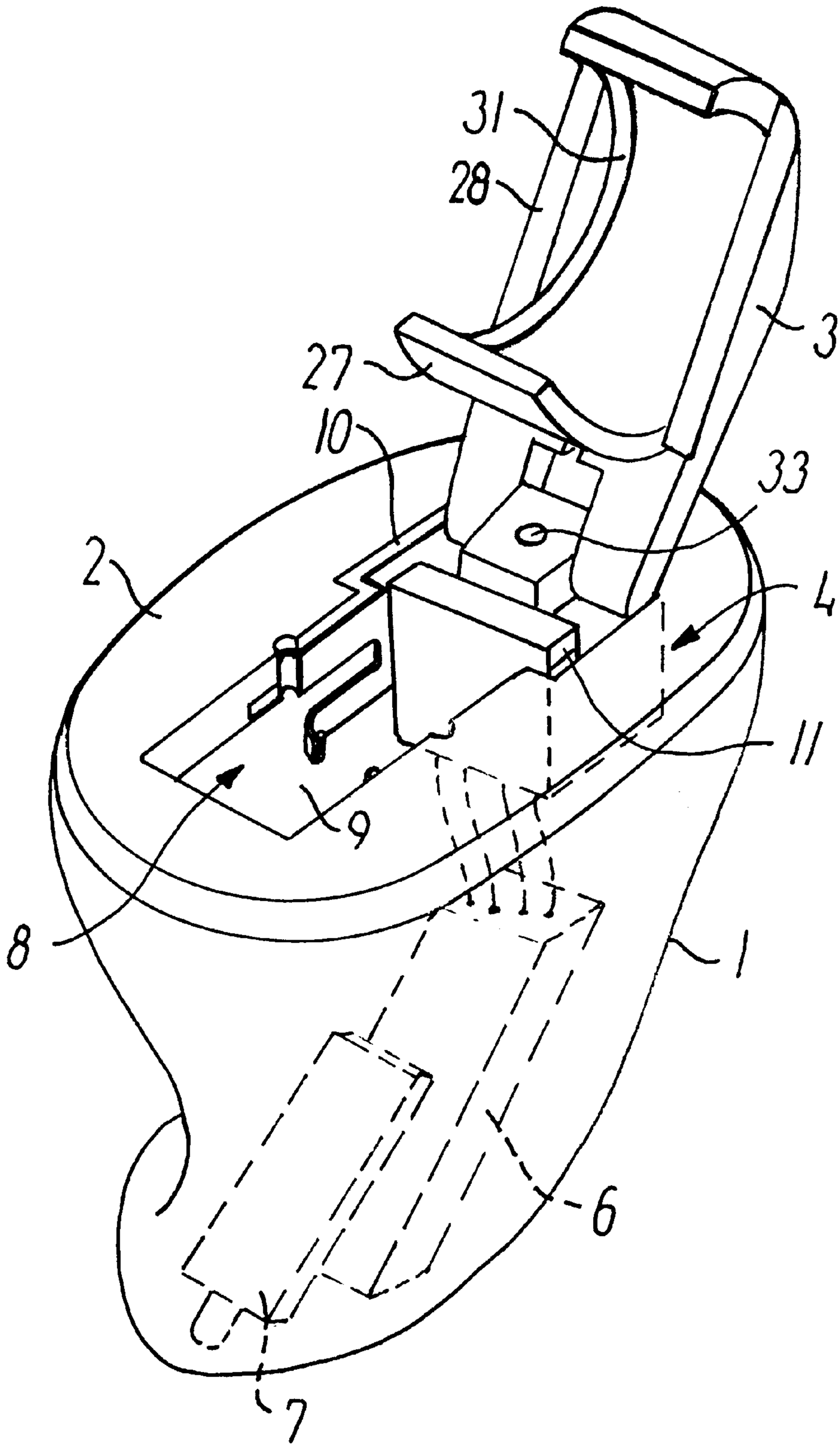


FIG. 1

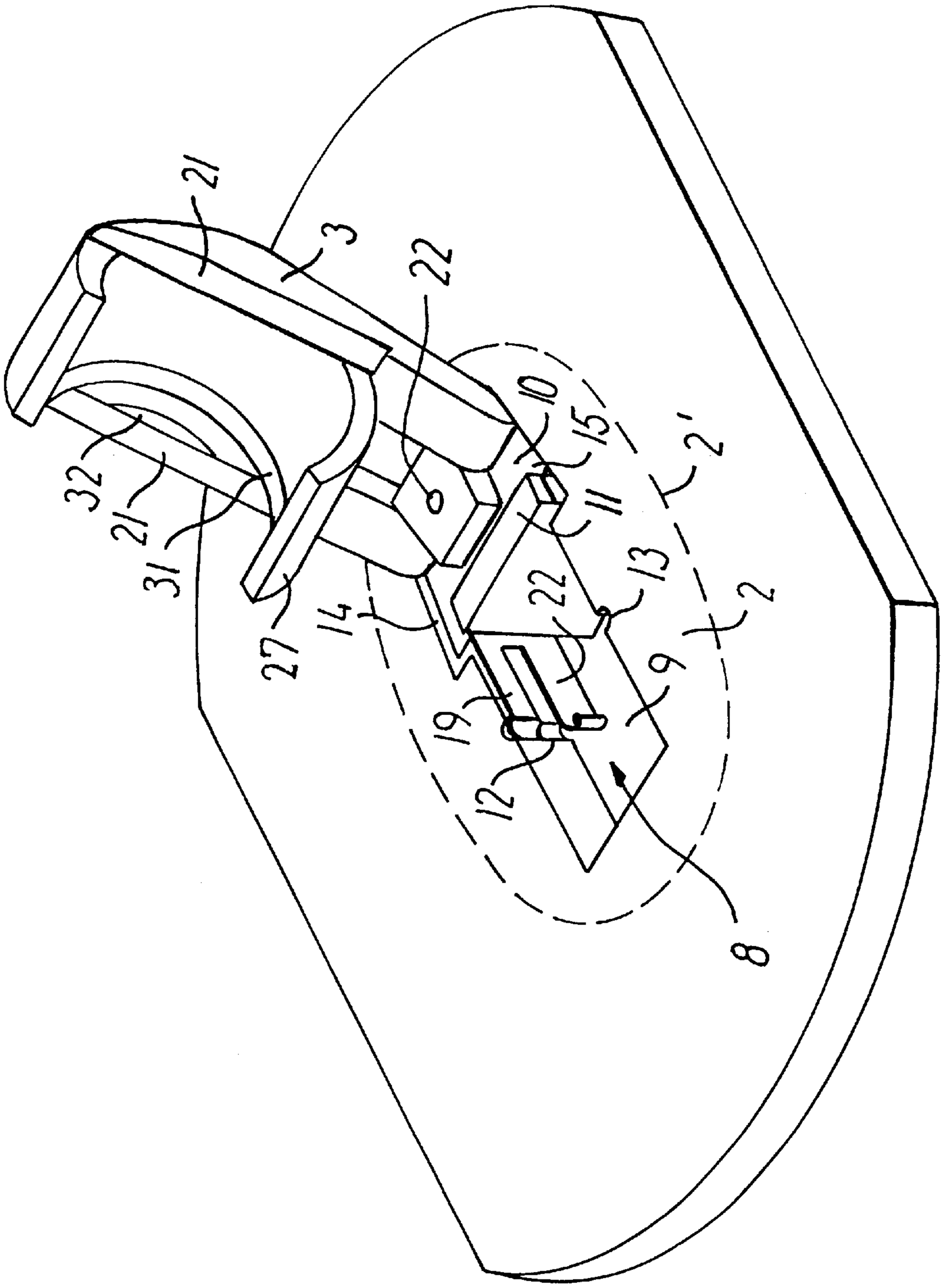


FIG.2

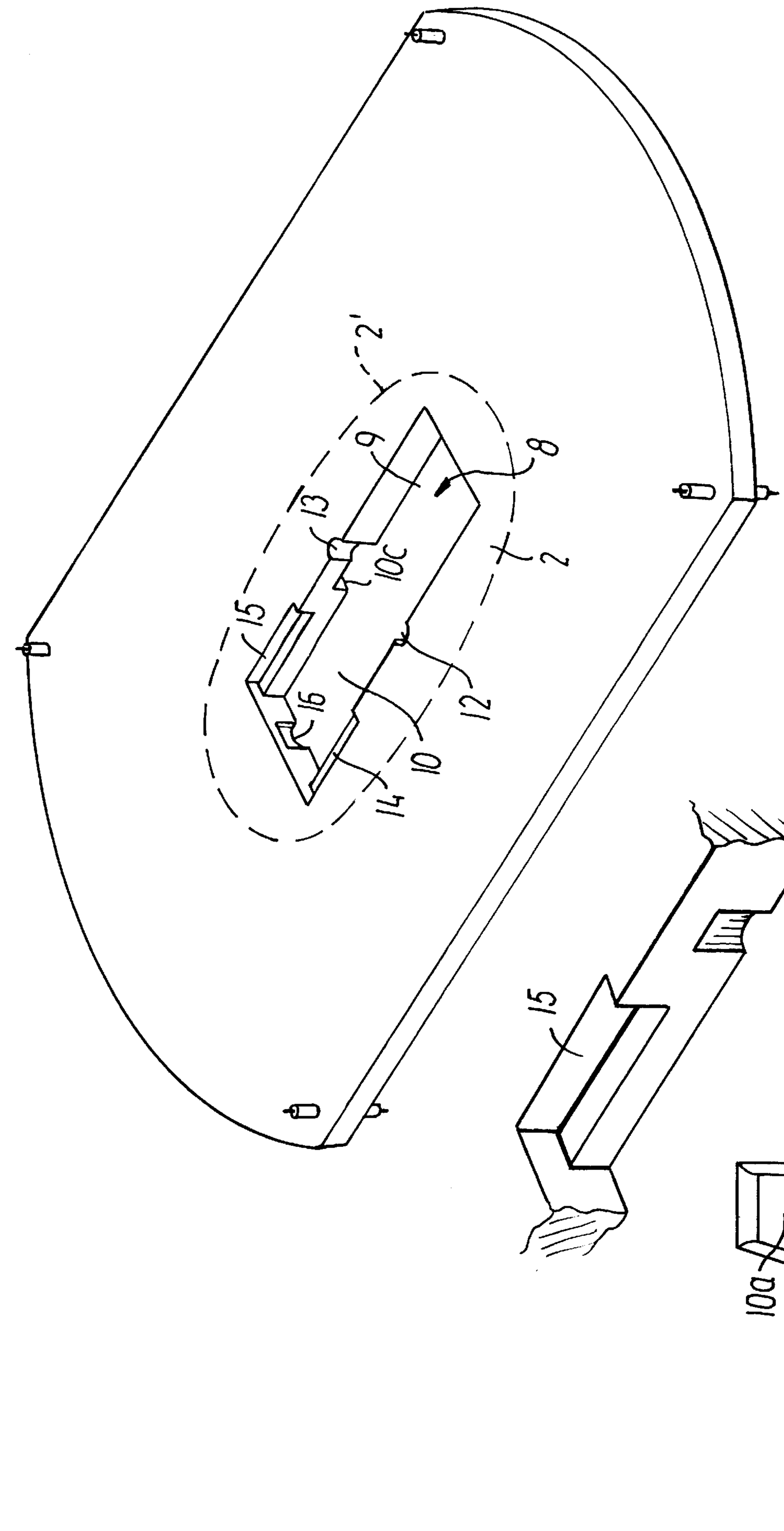


FIG.3

FIG.4

FIG.5

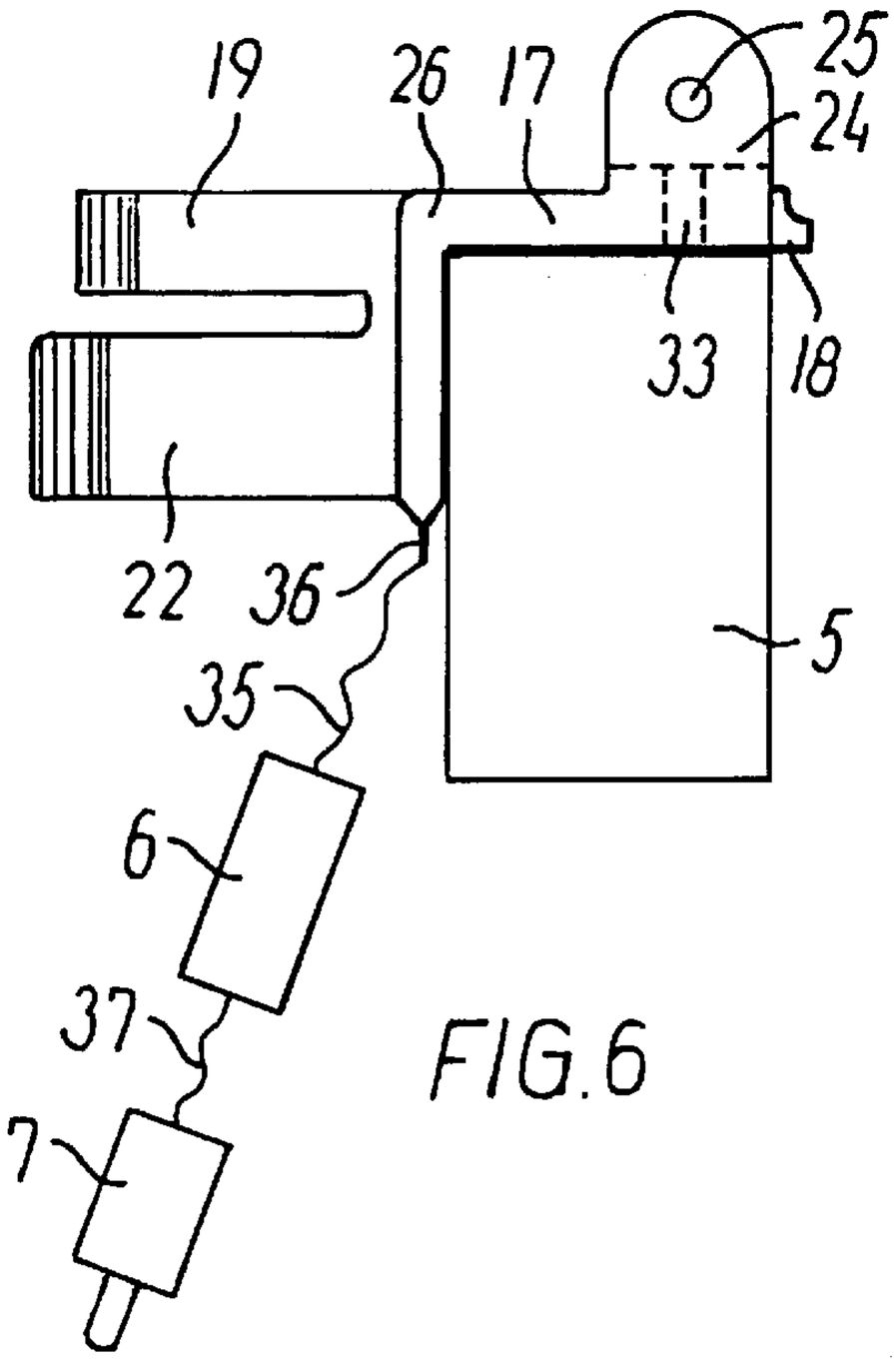


FIG.6

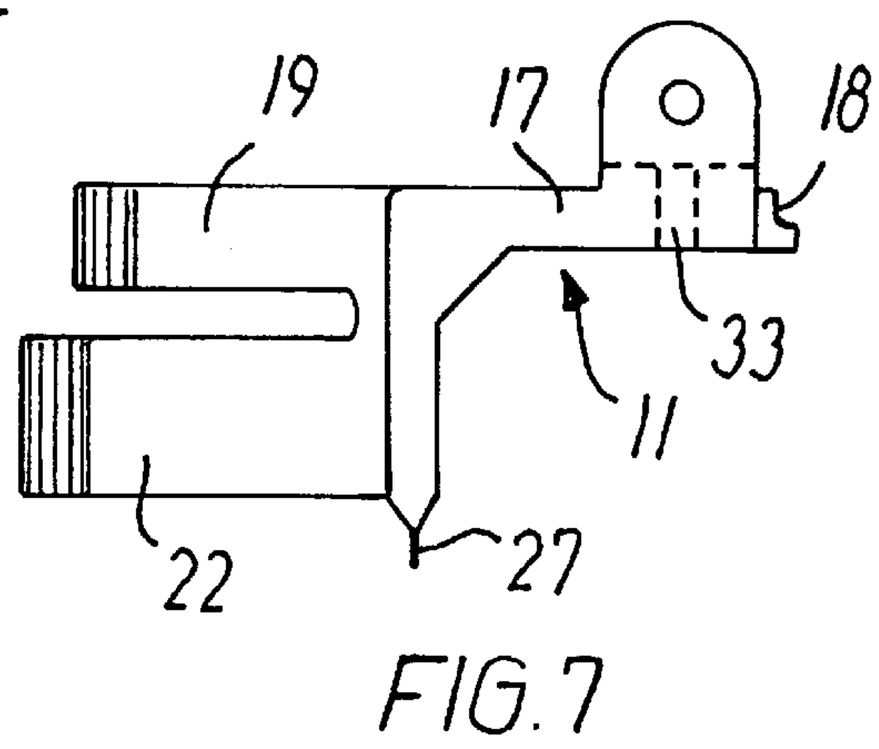


FIG.7

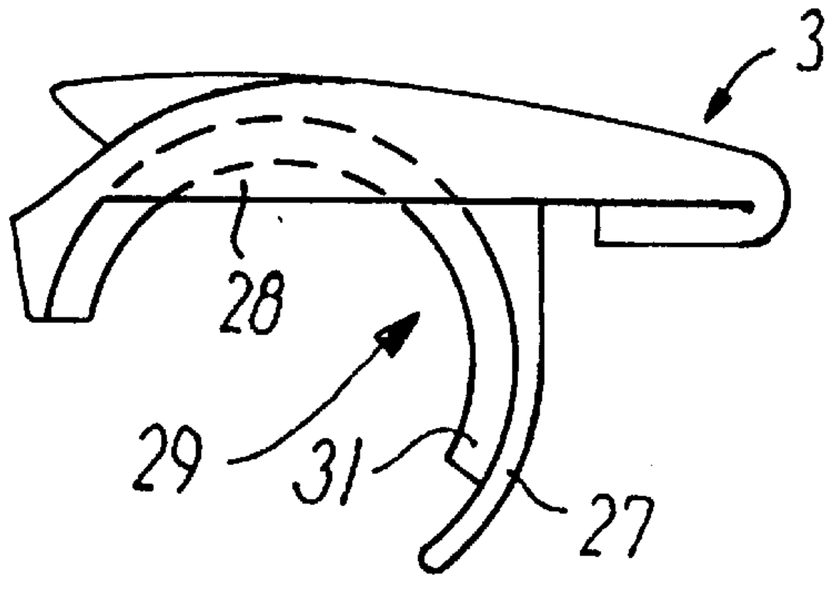


FIG.8

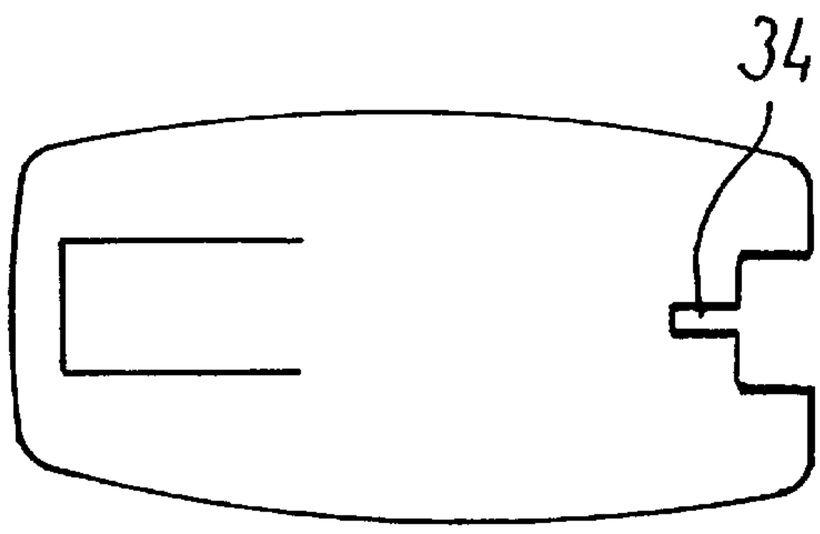


FIG.9

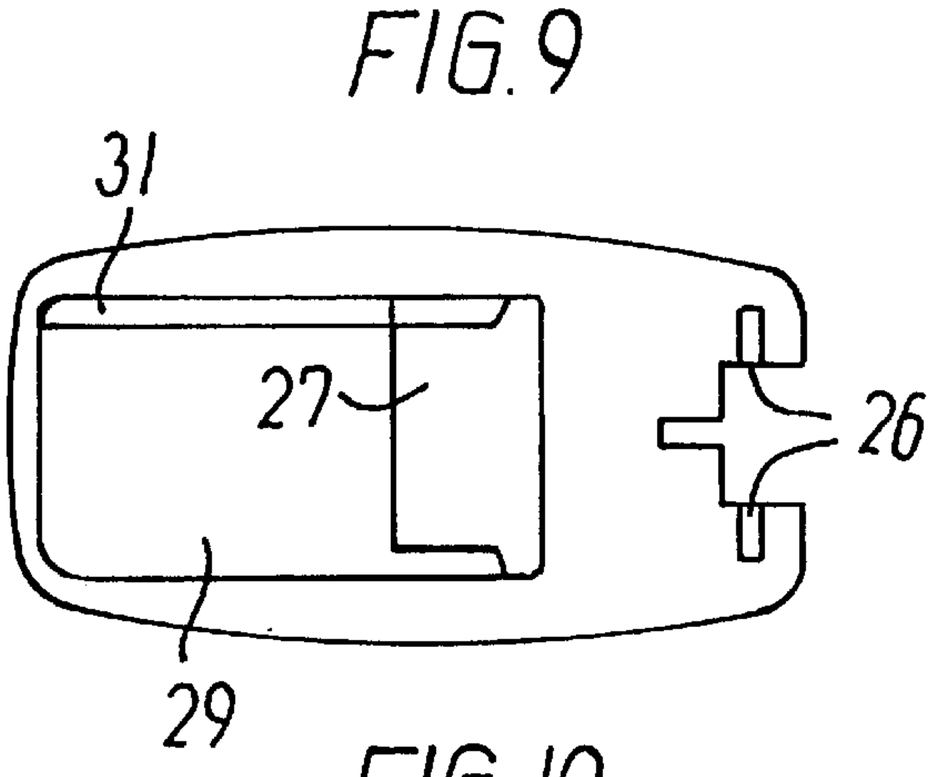


FIG.10

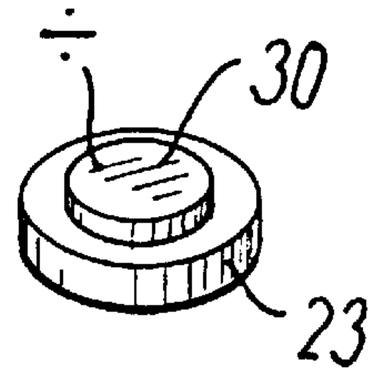


FIG.11

COMPACT MODULAR IN-THE-EAR HEARING AID

BACKGROUND OF THE INVENTION

The present invention relates to a modular hearing aid for arrangement in a user's ear, particularly completely inside the ear canal, comprising a hollow plug adapted to the ear canal and having a generally irregular conical shape and an outward opening which is covered by a faceplate in which a recess is formed for removable arrangement of a battery as well as an electronic module comprising a microphone, a signal processing part and a sound reproducer.

While conventional hearing aids in a so-called BTE design for arrangement behind a user's ear are usually manufactured with a housing of a size that allows relatively easy separation for replacement of battery and possibly removal of electronic components for repair, etc., hearing aids of the above designs, i.e., of a so-called ITE design for arrangement in the ear, normally in the funnel-shaped outer part of the ear canal, or of a so-called CIC design for arrangement completely inside the ear canal, require a very compact design of the housing or plug of the hearing aid to allow it partly to be arranged in the ear canal, partly to house the components necessary for operation of the hearing aid, such as battery and electronic components for sound reception, signal processing and sound reproduction.

For manufacturing reasons, such hearing aids are therefore normally built up by joining together a plug or shell, which is adapted in shape and dimensions to the ear canal of the actual user and has an external faceplate to which the electronic components are glued or otherwise fastened so that by gluing of the faceplate to the user-adapted plug or shell they are localized therein in a protected manner. In conventional hearing aids of this type, such as are known from, e.g., published European patent application EP A2-0 311 233 and U.S. Pat. No. 4,680,799, it is therefore usually necessary in connection with replacement or repair of electronic components to break the shell or the faceplate by milling or in any other way, which renders repairs difficult and more expensive and means that the shell and/or the faceplate must be re-established after repair.

An attempt has been made to alleviate the disadvantages connected with this by means of a hearing aid design known from published German patent application DE-C1-41 21 311, in which the microphone part and the signal processing part of an electronic module are placed together with the battery in an insert part for removable mounting in the faceplate.

This insert part or mounting plate is, however, relatively large compared with the overall size of the faceplate and therefore requires a corresponding increase of the size of the recess, which limits the possibilities of final adaptation of the external contour of the faceplate, for example by buffing in connection with joining the faceplate with the user-adapted shell or plug, to an undesired degree. Furthermore, the manufacturing of these known hearing aids is made more complicated and expensive by the requirement for a separate insert part or mounting plate for the electronic components.

In another design known from U.S. Pat. No. 5,201,008, an electronic module is removably fastened in a faceplate, here constituted by a rim portion at the external orifice of the user-adapted plug or shell, which is closed in its entirety by a hinge-connected lid. This apparatus design is substantially more complex and expensive due to the need for a separate holder for the electronic module and a complicated lid design.

SUMMARY OF THE INVENTION

From this point of departure, the object of the invention is to provide a hearing aid of the type stated, in which the possibility of a non-destructive removal of the electronic module from the hearing aid housing is obtained without any noticeable limitation of the possibilities of final adaptation of the outer contour of the faceplate to a user-adapted ear canal plug or shell.

To obtain this, the modular hearing aid according to the invention is characterized in that the recess comprises a first region for insertion of the battery and a second region coherent with the first region for placing of a socket part of the electronic module, while further parts thereof are placed below the faceplate, that at the edge of the recess the faceplate is formed with engaging means for said socket part, and that the recess is formed so that at removal of the battery the first and second regions together allow passage also of said further parts for removal of the complete electronic module.

Through said design of the recess in the faceplate, whereby the faceplate only has to retain a less space-consuming part of the aggregate electronic module in the form of said socket part, which may, for example, comprise only the microphone part, which has to lie close to the faceplate in consideration of reception of the sound, the intended removability of the electronic module can be obtained without any marked increase of the size of the recess compared with what is required in consideration of replacement of the battery.

Advantageous embodiments and features of the invention appear from the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be explained in more detail below with reference to the schematic drawing, in which

FIG. **1** is a perspective view of an embodiment of a modular hearing aid according to the invention,

FIG. **2** is a perspective view of a faceplate for use in the hearing aid of FIG. **1** with an inserted electronic module and a battery lid connected with the faceplate,

FIG. **3** is a perspective view of the faceplate itself,

FIGS. **4** and **5** show details in the design of the faceplate,

FIGS. **6** and **7** are examples of an electronic module for use in the hearing aid of FIG. **1**,

FIGS. **8–10** show the design of a battery lid connected with the faceplate, and

FIG. **11** is an example of a hearing aid battery for use in the hearing aid of FIG. **1**.

DETAILED DESCRIPTION OF THE INVENTION

The embodiment shown in FIG. **1** of a so-called ITE hearing aid for arrangement in the user's ear canal comprises a hollow plug **1** adapted to the ear canal and having a generally irregular conical shape, an external faceplate **2** covering the outward opening of the plug **1**, a battery lid **3** pivotally connected with the faceplate **2**, and an electronic module **4** having a microphone **5**, a signal processing part **6** and a sound reproducer in the form of a receiver **7**.

At the narrow end, which faces the interior of the ear canal during use, the plug **1** is formed with a sound exit hole, not shown, through which sound produced by the receiver **7** can be passed on to the interior of the ear.

When a hearing aid is adapted to a user's ear, the shape of the plug **1** is usually individually adapted to the ear canal,

but the plug **1** may, however, also be manufactured as a standard component. The faceplate **2**, which is usually a standard component and may be formed as shown in FIGS. **2** and **3**, is then glued over the outward opening of the plug **1**. After gluing, the contour of the faceplate **2** is then formed by cutting or milling according to the contour of the edge of the orifice of the plug **1**, as marked by a dashed line **2'** in FIG. **2**. After finishing of the plug **1** with the glued-on and contour-adapted faceplate **2**, the other components are mounted in the hearing aid, which provides the manufacturing advantage that the plug **1** with the faceplate **2** can be cleaned after the finishing so that the other components are not exposed to pollution during their mounting.

As shown in FIGS. **1–3**, a recess **8** is formed in the faceplate **2** for removable arrangement of a battery, which may be formed as shown in FIG. **11** and is inserted in the lid **3**, formed as a battery holder, as well as the electronic module **4**. For this purpose, the recess **8** comprises a first region **9** for positioning of the battery and a second region **10** coherent therewith for insertion of a socket part **11** of the electronic module **4**, which houses the microphone part **5** of the module.

To retain the socket part **11** of the electronic module **4**, integral engaging means are formed at the edge of the recess **8**, as shown in FIGS. **2** and **3**, and, in the embodiment shown, comprise a pair of grooves **12** and **13** which are arranged opposite to each other at opposite edges of the recess **8** in the first region **9** for positioning of the battery. These grooves **12** and **13** serve to retain the socket part **11** against displacement in the plane of the faceplate **2**. The engaging means further comprise a pair of tracks **14** and **15** facing each other for retention of the socket part **11** against displacement at right angles to the faceplate **2** into the plug **1** and a notch **16** for retention of the socket part **11** against displacement in the opposite direction.

For engagement with the engaging means formed in the faceplate **2**, the socket part **11** of the electronic module **4**, as seen more clearly in FIGS. **6** and **7**, is formed with sideways projecting ribs **17** for arrangement in the tracks **14** and **15**, and with a cam-like, backward projection **18** for engagement with the notch **16**, and with protruding resilient lugs **19** for localization in the grooves **12** and **13**.

When the electronic module **4** is arranged in the faceplate **2** with the battery lid **3** pivoted out to the position shown in FIGS. **1** and **2**, the parts of the electronic module intended for arrangement in the plug **1** under the faceplate **2**, i.e., the signal processing part **6** and the receiver **7**, are passed through the recess **8** down into the plug **1**. The socket part **11** is then placed with the ribs **17** in the tracks **14** and **15** and is displaced in or pivoted towards the plane of the faceplate **2** so that the projection **18** is brought into engagement with the notch **16**, whereby the resilient lugs **19** also engage with the grooves **12** and **13**.

The engaging means at the edges of the recess **8** and the matching engaging means on the socket part **11** of the electronic module **4** may be formed so that the electronic module **4** is passed substantially at a right angle into the second region **10** of the recess **8** and is then displaced in the plane of the faceplate for provision of the engagements described above. Preferably, however, the socket part **11** is passed at an oblique angle into the recess **8** with abutment on its edge at the notch **16**, whereupon the socket part is pivoted into place and fastened by engagement of the resilient lugs **19** with the grooves **12** and **13** and of the projection **18** with the notch **16**. In this design, the end of the tracks **14**, **15** and the corresponding ends of the ribs **17** may be formed for abutment on each other and for retention of the socket part **11** against displacement in the plane of the faceplate **2** after mounting of the socket part in the recess **8**.

When the electronic module **4** is removed from the hearing aid, the resilient lugs **19** can be released from their engagement with the grooves **12** and **13** by means of a suitable tool, whereupon the socket part **11** is pivoted upwards with the back edge at the notch **16** as the pivot axis for release of the projection **18** from its engagement with the notch **16** so that the socket part **11** can be removed from the faceplate **2**, and the other components **6** and **7** of the electronic module **4** can be lifted out from the interior of the plug **1** through the recess **8**.

This design, where the socket part **11** can be pivoted in and out of its position is especially advantageous as the engaging means **12–16** of this design, apart from being formed compactly, do not require space for displacement of the socket part **11** into the region **9** at insertion and removal. The design at the same time still provides good retention of the socket part **11**, as the resilient lugs **19** project into the region **9** for positioning of the battery and here act as levers that provide a strong fastening of the socket part and prevent its unintended pivoting out after the mounting. The relatively large distance whereby the resilient lugs **19** project into the region **9** at the same time makes it easy to remove the socket part **11**, as by intention the lugs **19** can easily be pushed out of engagement by a relatively small use of force at the outer ends of the lugs **19**.

FIG. **4** shows an alternative design of the engaging means at the edge of the recess **8**, the grooves **12** and **13** being replaced by upwardly closed recesses **20**. Another possibility is that the grooves **12** and **13** may open out downwards into groove tracks **13***a* which, as shown in FIG. **3**, expand from the recess. This design provides good engagement of the resilient lugs **19** against unintended pivoting out of engagement.

Another alternative design of the engaging means appears from FIG. **5**, where the second region **10***a* of the recess **8** has a truncated wedge shape. The tracks **14** and **15** and the notch **16** are here replaced by inwardly projecting, arched ribs **21** at opposite edges of the recess **8**, which retain the socket part **11** in both directions at right angles to the faceplate **2** by engagement with adapted grooves in the socket part **11** instead of the ribs **17**.

As shown in FIGS. **6** and **7**, the protruding resilient lugs **19** from the socket part **11** may suitably be formed with integral battery terminals **22**, as after mounting of the socket part **11** these lugs project into the first region of the recess **8**, where they can be contacted by the terminals on the battery **23** shown in FIG. **11**, when it is swung into its operative position by closure of the pivotal lid **3**.

In the embodiment shown, the pivotal battery lid **3** is hinge-connected to the socket part **11** of the electronic module **4** by the socket part being formed with hinge bearings **24** with holders for a pin **25** which can engage with hinge tracks **26** formed at one end of the battery lid **3**.

To retain the battery **23**, the battery lid **3** has a partially cylindrical wall **27** extending over at least 180° and defining a battery space **29** together with circular-section-shaped edge flanges **28**. One terminal, usually the negative terminal on the battery **23**, is formed as a pole button **30** as shown in FIG. **11**, and the cylindrical wall **27** at one side of the battery lid **3** may be formed with an upright annular edge **31** which, at correct arrangement of the battery, encloses the pole button **30**, but which, if the battery is turned the wrong way, causes the battery lid **3** to be non-closeable. This prevents

insertion of the battery with an incorrect polarization. In the embodiment shown, where the battery lid **3** is formed with edge flanges **28** at both sides, the side of the edge flange **28** where the pole button **30** is placed is formed with a depression **32** providing room for the pole button.

When the battery lid **3** is closed, the circular-section-shaped edge flanges **28** abut on the exterior of the faceplate **2** around the recess **8**, ensuring correct positioning of the battery **23** at its insertion into the first region **9** of the recess **8**, while at the same time the faceplate **2** can be manufactured in a relatively simple standard design as a plane disc-shaped body without protruding abutment for the battery lid, whereby the manufacturing of the aggregate hearing aid is simplified and made cheaper, and mounting and removal of the components of the electronic module are facilitated.

As it appears particularly from FIGS. **1**, **2** and **8**, the design of the battery lid results in retention of the battery **23** with uncovered battery terminals formed by the pole button **30** and the end surface of the battery opposite thereto so that at closure of the battery lid, the terminals are directly brought into contact with the integral battery terminals on the resilient lugs **19** on the socket part **11**.

At the closure of the battery lid, the main part of the partially cylindrical wall **27** will furthermore be placed up against the socket part **11**, while the remaining part of the circumferential surface of the battery is not enclosed by any socket that would take up space in the interior of the plug **1**. The wall of the plug **1** can be located very close to the battery so that the plug can be formed with small dimensions.

In addition to causing accurate positioning and retention of the electronic module in relation to the faceplate **2**, the design of the socket part **11** described above means that it supports the battery terminals **22** of the electronic module directly, and through the hinge connection with the battery lid it causes a secure guiding of the battery during closure of the battery lid.

In the electronic module, the microphone part **5**, as it appears particularly from FIGS. **1**, **2** and **6**, is directly connected with the socket part **11** and communicates with the surroundings through microphone ports **33** and **34** formed in the socket part **11** and the battery lid **3**, respectively, so that with a closed battery lid they correspond mutually to ensure well-defined sound access to the microphone part **5**. In the embodiment shown, the microphone port **34** in the battery lid **3** is formed as an open slit which can relatively easily be cleaned at soiling through opening of the battery lid **3**.

The signal processing part **6** with the amplifier circuit of the hearing aid is connected via flexible wires **35** to terminals **36** on the socket part **11**, and correspondingly, the telephone **7** is connected with the signal processing part **6** via flexible wires **37**. This allows the most suitable arrangement of the signal processing part **6** and the telephone **7** in the individually adapted plug **1**.

The design described above of the modular hearing aid according to the invention with the individually adapted plug **1**, the faceplate **2** fastened to the plug **1** and formed according to its contour, the battery lid **3** and its hinge connection with the socket part of the electronic module **4** allows an extremely expedient and economic manufacturing together with a very compact design that allows manufacturing of individually adapted ITE hearing aids of reduced dimensions, which it was formerly only possible to obtain with hearing aids of a standard design, i.e., without individual adaptation of the ear canal plug.

What is claimed is:

1. A modular hearing aid for arrangement in a user's ear, comprising:

a hollow plug adapted to the ear canal and having a generally irregular conical shape and an outward opening,

an electronic module positioned in the plug and comprising a socket part, and also comprising further parts including a microphone, a signal processor, and a sound reproducer, and

a faceplate covering said opening and having a recess defined therein, said recess comprising a first region for insertion of a battery and a second region contiguous with the first region for receiving the socket part of the electronic module, while the further parts of said electronic module are placed below the faceplate, said faceplate being formed at an edge of said recess with an integral engagement structure for said socket part,

said recess being formed such that after removal of said battery and said socket part said first and second regions together allow passage also of said further parts for removal of the complete electronic module.

2. A hearing aid according to claim **1**, wherein said engagement structure of the faceplate comprise grooves, tracks and/or notches for engagement with engaging means formed on said socket part.

3. A hearing aid according to claim **2**, wherein said engaging means on the socket part comprise elastically resilient lugs for engagement with said grooves.

4. A hearing aid according to claim **3**, wherein said lugs are formed as elements which project from said socket part and which, in the mounted position of the socket part, protrude into the first region of the recess.

5. A hearing aid according to claim **4**, wherein said lugs are integrated with battery terminals projecting from said socket part.

6. A hearing aid according to claim **1**, wherein said recess can be covered by a pivotal lid for reception and support of said battery, and wherein said lid is hinge-connected with said socket part.

7. A hearing aid according to claim **1**, wherein said recess can be covered by a pivoted lid for reception and support of said battery, and wherein the battery lid is formed with a partially cylindrical wall which encloses the battery over at least 180° and forms a battery space together with substantially circular-section-shaped edge flanges.

8. A hearing aid according to claim **7**, wherein at one side of the battery space, said partially cylindrical wall is formed with an upright annular edge for enclosure of a pole button on the battery defining one terminal of the battery.

9. A hearing aid according to claim **1**, wherein the microphone part of the electronic module is fastened to said socket part, while the signal processing part and the sound reproducer are interconnected and connected with said socket part via flexible wire connections.

10. A hearing aid according to claim **9**, wherein microphone ports are formed in the battery lid and the socket part and correspond mutually when the battery lid is closed.

11. A hearing aid according to claim **1**, wherein an area of said recess is less than an area of said opening.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,430,296 B1
DATED : August 6, 2002
INVENTOR(S) : Jorgen M. Olsen

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Title page,
Item [56], FOREIGN PATENT DOCUMENTS, change "CH 68311" to
-- CH 683811 A5 5/1994 --

Signed and Sealed this

Third Day of June, 2003

JAMES E. ROGAN
Director of the United States Patent and Trademark Office

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,430,296 B1
DATED : August 6, 2002
INVENTOR(S) : Jorgen M. Olsen

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Title page,
Item [73], correct the Assignee from "**Topholm & Westermann APS**" to
-- [73] Assignee: **Widex A/S**, Vaerloese (DK) --

Signed and Sealed this

Twenty-ninth Day of July, 2003

JAMES E. ROGAN
Director of the United States Patent and Trademark Office